HOMEWORK 2
DIFFERENTIAL EQUATIONS
DUE 2014-09-02

Show your work unless otherwise specified.

(1) In class, we considered the model of a falling penny given by $\ddot{h} = -32$ with $h(0) = 567$ and $\dot{h}(0) = 0$. Using the step size $\Delta t = 0.5$, we filled out the first three rows of *approximate* values:

t	h	$\dot{h}$
0	567	0
0.5	567	-16
1	559	-32
1.5		
2		
2.5		
3		
3.5		
4		
4.5		
5		
5.5		
6		
6.5		
7		

(a) Fill out the fourth and fifth rows. Show your work.

(b) Fill out the remaining rows of the table until your answers indicate that the penny has hit the ground. You may use a computer (including the `EulersMethod` tool in `DETools`), and need not show your work.

(c) According to this approximation, during which step does the penny hit the ground?

(2) A more realistic model than #1 for a falling penny includes a Newton drag term:

$$\ddot{h} = -32 + C\dot{h}^2.$$

(This is just another way of writing $a = -32 + Cv^2$.) Suppose that $C = 0.05\ \frac{1}{\text{ft}}$. Use $\Delta t = 1$ to fill out the fourth and fifth rows of the following table. Show your work.

t	h	$\dot{h}$
0	567	0
1	567	-32
2	535	-12.8
3		
4		

(3) If you try to repeat #2 with $h(0) = 567$, $\dot{h}(0) = 0$, $C = 0.1\ \frac{1}{\text{ft}}$, and $\Delta t = 1$, then the mathematical answer that you get has a big physical problem. What is it?

(4) Your friend is trying to model a falling penny subject to *Stokes drag*, where the magnitude of the drag on the penny is proportional to the speed of the penny (not the square of the speed, as in Newton drag). He chooses the up direction to be positive, and comes up with the model

$$\dot{v} = -32 + Cv.$$

(a) What mistake has your friend made? (HINT: Consider the signs.)

(b) What is the correct formula?

(c) What are the units of C?

- **One** book problem: #1.4.4 (p. 61).